Photovoltaic Systems

Since their first commercial use in 1957, the cost of solar electric (photovoltaic or PV) cells has dropped over a hundred-fold. Today solar electric systems are widely used to provide electricity at remote sites for home power, telecommunications, lighting, water pumping and many other uses.

The cost of solar electricity is still several times more expensive than conventional power from the utility grid, but the high cost of running electric distribution lines from the grid to remote sites often makes solar electric systems comparatively less expensive. In Vermont, the cost of building power distribution lines averages about $40,000 a mile. This can make solar electricity the least-cost option for new homes that are as little as a quarter mile from existing lines.

How Do They Work?

The heart of a solar electric system is the *photovoltaic module*. A module is composed of silicon wafers that produce direct current (DC) electricity when exposed to light. This electricity is produced with no moving parts and no chemical reaction, making the modules reliable and pollution free. A typical solar electric system for a full-time residence in Vermont will normally have about twelve to twenty-four 50-watt PV modules, producing about 75 to 150 kilowatt-hours (kWh) a month. These modules measure about 1-1/2' x 4', or six-square feet in area.

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This energy is not used directly, however, but used to charge a *deep-cycle battery bank*. Typically, the battery bank is sized to store enough energy to power the home for a week. A *charge controller* automatically regulates the charging current from the PV modules keeping the batteries

from being undercharged or overcharged. Energy from the battery bank is then used to power an *invertor* that supplies 120-volt AC current for standard household appliances.

Because Vermont's weather is so variable, and because there is only half as much sunshine in the three worst winter months as in the rest of the year, most large systems include a gas or propane fueled *generator* that can be used to run appliances and charge the battery bank when necessary. Though the system relies primarily on solar energy, the addition of a backup generator gives a system much more flexibility to meet changing weather patterns and household electrical use.

Since PV modules are solid-state devices with no moving parts, they are extremely reliable and require no maintenance for the lifetime of the system. The only part of the system that requires maintenance are the batteries which must be periodically checked and replaced about every eight years for lead acid batteries or every 15 years for nickel-cadmium batteries.

The Importance of Energy Efficiency

The average American family with utility service uses about 750 kilowatt-hours (kWh) a month. Understanding how families with solar electric systems can get by on only a fraction of typical power consumption is the key to understanding cost-effective photovoltaic applications.

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A fundamental consideration in the design of any independent power system is energy efficiency. The first rule is to use electricity only for purposes where it is best suited — such as lighting, electronics and motors — not for water or space heating, cooking or drying, all of which can be done less expensively by propane, oil or solar thermal systems.

The second rule is to make sure electric appliances are the most energy-efficient ones available. Almost all PV powered homes, for example, use high-efficiency compact fluorescent light bulbs. These use one-quarter of the energy of an equally bright incandescent bulb and do not have the harsh color or flicker associated with conventional fluorescent tubes.

High-efficiency lights and appliances cost more initially. The extra capital investment may cost several thousand dollars for a typical household. This cost, however, is offset many times by being able to install a smaller solar electric system.

Other Ways To Generate Electricity

Other renewable energy systems, such as wind and "micro" hydro turbines, can generate electricity at a remote site. Unlike sunshine which is available everywhere, wind and water resources are site specific and must be available in sufficient quantity to power a turbine.

Wind and hydro power systems are also mechanical systems that require maintenance. For this reason, solar electric systems are better suited to homeowners who require a fairly maintenance-free electrical system.

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Making the Right Choice

For prospective homeowners building on a remote site or buying a house without utility power, photovoltaic technology has opened up new options.

At the same time, photovoltaics are not appropriate for every remote home or every family. Lack of solar access or large electrical

needs may make such a system impractical.

The following rule of thumb should be used by prospective home or land buyers looking at property beyond the grid: If the cost of bringing in power is more than $1,000 for a weekend cabin or more than $5,000 for a full-time residence, then solar electricity is worth investigating.

The first step is to become educated about PV systems and then find a reputable solar electric contractor. Remember not everyone selling systems is necessarily competent to design and install them. Find someone who has experience installing systems and then talk with the owners of those systems.

A good contractor can help you assess your real power needs, design the most cost-effective system and make sure the system is installed according to the National Electrical Code and applicable state codes. Most importantly, he or she will be a valuable advisor as you learn to manage your own solar-powered utility.